University of Victoria | Graduate Studies

PROGRAMME

The Final Oral Examination
for the Degree of

DOCTOR OF PHILOSOPHY
(Department of Mechanical Engineering)

Kate Jackson

2010	University of Victoria	MASc
2008	University of British Columbia	BSc

"Dynamic Tomographic Algorithms for Multi-Object Adaptive Optics: Increasing sky-coverage by increasing the limiting magnitude for Raven, a science and technology demonstrator"

Tuesday, August, 26, 2014
9:00 A.M.
David Turpin Building, Room A137

Supervisory Committee:
Dr. Colin Bradley, Department of Mechanical Engineering, UVic (Supervisor)
Dr. Carlos Correia, Department of Mechanical Engineering, UVic (Member)
Dr. Wu-Sheng Lu, Department of Electrical and Computer Engineering, UVic (Outside Member)

External Examiner:
Dr. Richard Myers, Faculty of Science, Durham University

Chair of Oral Examination:
Dr. Dennis Hore, Department of Chemistry, UVic

Abstract

This dissertation outlines the development of static and dynamic tomographic wave-front (WF) reconstructors tailored to Multi-Object Adaptive Optics (MOAO). They are applied to Raven, the first MOAO science and technology demonstrator recently installed on an 8m telescope, with the goal of increasing the limiting magnitude in order to increase sky coverage. The results of a new minimum mean-square error (MMSE) solution based on spatio-angular (SA) correlation functions are shown, which adopts a zonal representation of the wave-front and its associated signals. This solution is outlined for the static reconstructor and then extended for the use of stand-alone temporal prediction. Furthermore, it is implemented as the prediction model in a pupil plane based Linear Quadratic Gaussian (LQG) algorithm. The algorithms have been fully tested in the laboratory and compared to the results from Monte-Carlo simulations of the Raven system. The simulations indicate that an increase in limiting magnitude of up to one magnitude can be expected when prediction is implemented. Two or more magnitudes of improvement may be achievable when the LQG is used. These results are confirmed by laboratory measurements.

Awards, Scholarships, Fellowships

2012 – Graduate Award, University of Victoria

2003 – Entrance Scholarship, University of British Columbia

2003 – Academic Award, Vancouver Foundation

Presentations

1. Jackson, K.; Correia, C.; Lardiere, O.; Andersen, D. and Bradley, C., "*Tomographic wavefront error estimation and measurement for Raven, a multi-object adaptive optics demonstrator."* SPIE Astronomical Telescopes + Instrumentation, Amsterdam, Netherlands, June 2012 (poster).
2. Jackson, K.; Correia, C.; Lardiere, O.; Andersen, D. and Bradley, C. "*Tomography for Raven, a Multi-Object Adaptive Optics Science and Technology Demonstrator."* 13th Advanced Maui Optical and Space Surveillance Conference, Maui, USA, Sept 2012 (poster).
3. Jackson, K.; Correia, C.; Lardiere, O.; Andersen, D.; Bradley, C.; Pham, L.; Blain, C.; Nash, R.; Gamroth, D., *"Tomography and calibration for Raven: from simulations to laboratory results."* SPIE Astronomical Telescopes + Instrumentation, Montreal, Canada, June 2014 (oral).

Publications

1. Andersen, D.; Jackson, K.; Blain, C.; Bradley, C.; Correia, C.; Ito, M.; Lardiere, O.; Veran, J.-P.; “Performance Modeling for the RAVEN Multi-Object Adaptive Optics Demonstrator.” *Publications of the Astronomical Society of the Pacific* **2012,** 124:469-484.

2. Correia, C.; Jackson, K.; Veran, J.-P.; Andersen, D.; Lardiere, O.; Bradley, C.; “Static and Predictive Tomographic Reconstruction for Wide-Field Multi-Object Adaptive Optics Systems.” *Journal of the Optical Society of America A*, **2014**, 31 (1), 101-113.